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Abstract

THE TREND TOWARDS HIGHER SPECIFIC RATINGS IN THE MAGNOX REACTOR IN BRITAIN

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The specific rating of a reactor directly affects the size of core, the pressure vessel, the biological shield and the site layout. These items are relatively expensive in magnox stations and hence there exists a prima facie incentive to go to higher ratings.

The specific reactor rating depends almost entirely on fuel rating and Vm/Vu.

Physics imposes tight limits on Vm/Vu hence increased specific rating means in practice increased fuel rating.

Fuel rating is limited by:

1. Endurance of fuel element and reactor core
2. Fuel handling (blow-out)
3. Safety

The problems associated with these three items tend to increase as fuel rating

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is increased, but this can be mitigated by appropriate choice of design features. For example, buffetting of the fuel element in the coolant gas stream will increase with fuel rating (higher coolant flow rate) but this can be offset by increasing the coolant pressure. Alternatively a more robust fuel element can be used, or the fuel surface to volume ratio might be increased leading to a lower channel pressure drop characteristic (at the expense of a reactivity penalty).

The British nuclear power stations from Berkeley to Wylfa show a significant rise in mean fuel rating, and associated with this a marked reduction in station construction costs. The increase in thermal ratings has demanded improved heat transfer surfaces for the fuel element and these have, in general, been provided by more closely packed and thinner magnox fins. The improved heat transfer performance has been associated with an increase in the pressure drop across the fuel channels. Gas pressures have therefore been increased in order to avoid excessive blower powers, and also to reduce the gas forces acting on the relatively weak fins. The introduction of prestressed concrete pressure vessels for the Oldbury and Wylfa designs has permitted higher gas pressures to be provided economically.

With solid uranium metal rods the mean fuel rating cannot be increased economically above about 1 MW(e)/Te. For higher ratings it is necessary to employ alternative fuel geometries having thinner sections and an enhanced surface heat transfer capability; for example a cluster of solid rods, tubular element, or a rectangular bar. In an economic comparison of these geometries the important characteristics are fuel fabrication cost and maximum permissible fuel rating. The former is influenced by the complexity of the assembly and the weight of uranium per assembly. The limiting fuel rating may be set by temperature limits, available reactivity, or heat transfer performance. The paper discusses the technical problems and economic trends of alternative fuel geometries within these limitations.